number of good friends who hasten to point out and correct such inaccuracy.

Here we have a life in which merit and good fortune have combined as they rarely do. No external difficulties have stood in the way of the straight-line development of the growing spirit, and the acknowledgments of his contemporaries have crowned his great merits soon enough to give his life the benefit of such stimulus. Thus he has come to be one of the great *international* investigators, known wherever science is cultivated. If we add that Sir William personally belongs to those unassuming and agreeable figures such as can only be found in the small circle of the front-rank men of science, and that his domestic fate, though not free from occasional cares, has given him a more than average degree of contentment, we have stated the conditions which lead us to expect that his sixtieth year of life, which he will shortly complete, will not by any means mark the close of an unusually rich and fruitful life's work.

WILHELM OSTWALD.

ARCHÆOLOGY IN THE "ENCYCLOPÆDIA BRITANNICA."

Collection of Articles (loose sheets) dealing with Ancient History and Archaeology, from the New (11th) Edition of the Encyclopaedia Britannica. (Cambridge University Press, n.d.)

IN no department of knowledge has greater progress been made during the last twenty years than in the realms of archæology and ancient history. A glance at almost any volume of the new edition of the "Encyclopædia Britannica" will bring this fact forcibly home to anyone. By means of the supplementary volumes, which were issued as an appendix to the tenth edition, it was attempted to summarise the course of such progress, and the result was certainly a series of interesting monographs by specialists, whose efforts were, however, largely controlled and cramped by the existence of articles on the same subjects in the earlier volumes, which were admittedly out of date. No such disadvantage characterises the eleventh edition. In fact, this new edition establishes a record of its own by the simultaneous issue of the whole of its twenty-eight volumes. Thus the purchaser has not to wait for years for the work to be completed. On the contrary, he obtains at once a marvellous summary of knowledge, every part of which has been subjected to a final revision by its author at the time of going to press. The amount of labour and organisation which must have been required to bring such a plan to a successful issue is little short of marvellous, and the editor has certainly reason to congratulate himself on the achievement.

His task must have been particularly arduous in keeping the archæological articles abreast of the most recent research. Yet in this section of the work, wherever we have tested it, he has not failed. Take, for instance, such an article as that on Ægean civilisation in the first volume. Here we have an admirable summary by Mr. D. G. Hogarth of the gradual discovery of the remains and their distribution, and a discussion of the general features of Ægean civilisation based upon them; yet even in such a moot section as that on the chronology, we find he has been enabled to make use of data quite recently acquired. The same remark applies to the series of careful monographs on ancient Egypt which have been contributed by several specialists, and to that on Babylonia and Assyria, the greater part of which is from the pen of Prof. Sayce. We have mentioned these three articles in particular as dealing with departments of archæology in which additions to our material and information are being constantly made. Yet, though they all occur within the earlier volumes, they represent the present state of our knowledge equally with those in the final volumes of the work.

With such a wealth of material to choose from, it is difficult to do more than indicate some of the more important and striking features of the present edition. In the arrangement of the material we have noted what appears to us an admirable innovation, the greater weight and prominence given to the general article. On one hand this enables a writer to lend additional interest to his subject by treating it from a more personal and less encyclopædic point of view. Such an article is Mr. C. H. Read's, on archæology, in which he has space, not only to summarise the headings of his subject, but also to discuss its value as a branch of science and the progress that has been made in its organised study. Thus, when dealing with the primitive epochs in the history of man, we note Mr. Read's timely warning to students of prehistoric archæology to use caution in their treatment of that much-debated problem as to whether traces of man have actually been found in deposits of the Tertiary period. As Mr. Read points out, there is no valid reason against the existence of Tertiary man, but the evidence in favour of the belief is not very convincing. For, on one hand, there is considerable doubt as to whether the deposits containing the remains are without doubt of Tertiary times; and, on the other, it is not certain whether the objects found show undoubted signs of human workmanship. On the latter point, a recurrent difficulty, and one which can never be entirely removed, is our ignorance of the precise methods of nature's working. It is certain that natural forces, such as glacial action, earthquake, landslips, and the like, must crush and chip flints and break up animal remains, grinding them and scratching them in masses of gravel or sand. It is almost impossible to separate the markings or crushing of flint and bone due to such natural agencies from others which may have been purposely made by man to serve some useful end. Even the one feature which is commonly held to determine human agency, the "bulb of percussion" (the lump or bulb on the face of a flint weapon at the end where the blow was delivered to detach it from the mass), is not conclusive evidence; for recent investigations have shown that natural forces frequently produce a similar result. Mr. Read's advice in deciding knotty points of this character may be summarised: use caution, and, where possible, obtain collateral evidence of some kind.

Another much-debated question, which is also discussed in the general article on archæology, concerns the apparent break of continuity in man's history which occurs in Europe at the end of the old Stone age, or Palæolithic period. Attempts have indeed been made to bridge this gap by means of a "Mesolithic" period; but the missing links do not occur, at any rate so far north as Britain. Here the last glimpse we get of Palæolithic man shows him living in a cold climate, hunting his prey and scratching his rude drawings on bone and rock, but with only a dawning knowledge of pottery; he sometimes shelters in caves, but generally camps in the open. His successor of the later Stone age is a very different person, living in a Britain which is practically the same as we see it to-day. The severe arctic conditions, with their appropriate fauna, consisting of mammoth, reindeer, &c., have entirely disappeared, and man himself has been changed by the introduction of new arts. Now Neolithic man probably immigrated into northern and central Europe long after Palæolithic man and his characteristic fauna had disappeared. Where then did the earlier race go, and has it any modern representatives? It would be tempting to accept Mr. Boyd Dawkins's theory that Palæolithic man followed the reindeer in its journey northward after the retreating glaciers, and that his modern representative is the Eskimo. But, as Mr. Read points out, the similarities in their culture may well be due to similar conditions of life, and are not convincing evidence of direct descent. Moreover, the skulls of the Eskimo do not resemble any of those of Palæolithic man hitherto found in the caves. In fact, we cannot yet answer this question, though if, as appears possible from recent discoveries in the south of France and in the Pyrenees, the reindeer was there in existence, along with man, at a later period than that of the caves, it is possible that Palæolithic man retreated southwards, and may have left no modern representative of a racial character sufficiently marked for recognition.

These two problems we have referred to, which are among those discussed under the heading of archæology, will serve to illustrate the use made of the general article in this new edition of the "Encyclopædia," in order to collect and discuss under one heading the more important aspects of a subject. Separate articles are, of course, still devoted to special points of interest, such as that on Hallstatt, to mention only one in this connection. In it Prof. Ridgeway gives a valuable account of the celebrated Celtic burial ground near Hallstatt, in Upper Austria, where it has been assumed that the use of iron was first developed, and afterwards spread thence southwards into Italy, Greece, the Ægean, Egypt, and Asia, and northwards and westwards in Europe. It is true that, while elsewhere in Europe and the Ægean the change from bronze weapons to iron is apparently sudden, at Hallstatt iron is seen gradually superseding bronze, first for ornament, then replacing fully the old bronze types of weapon, and finally taking new forms of its own. We may here note that, with regard to the earlier transition from stone to copper; a similarly gradual development has been noted by Prof. Reisner in Egypt at Naga-ed-Dêr and other prehistoric Egyptian cemeteries. On the strength of these results Prof. Elliot Smith a few months ago advanced the theory that Egypt was the original home of metal, and that its use spread thence eastwards into Asia and northwards into Europe and the Ægean area. But there is no need to regard the "Encyclopædia," which naturally can take no account of theories produced after its publication, as already out of date upon this point. For, while Prof. Reisner appears to have made out his case for the independent development of copper in Egypt, it appears to the present writer that there is no need to assume that no other race hit upon the same idea. In fact, it may be that M. de Morgan and his colleagues will some day find in Persia a proto-Elamite equivalent of Naga-ed-Dêr; and should this prove to be within easy reach of the tin supplies of Central Asia, it might also throw light upon disputed questions with regard to the transition from copper to bronze.

We have laid some stress upon the two last-named articles, as they are among the very few that have been sent us which have any bearing, direct or indirect, upon British archæology. We should have liked to refer to articles on Dolmens, Stone-circles, and their possible connection with astronomical ceremonies, and other subjects particularly connected with early British archæology, but the selection of articles sent us deals mostly with classical and Oriental subjects; and these will serve very well to illustrate other aspects of the work. We have already noted some characteristics of the general article in the new edition; another advantage, to which we may also direct attention, is that, where a wide survey is to be taken of material extending over various periods, it makes a far more detailed treatment possible. This is especially the case in the general articles of composite authorship. The treatment of ceramics is an instance in point. Here we are first presented with a general study of the art of pottery, which, both in its treatment and illustration, is such as we should look for in an encyclopædia. It is lucid and informing, and serves as an admirable introduction to anyone desirous of beginning a study of the subject. Such is all that could reasonably be expected of any encyclopædia. But the "Encyclopædia Britannica" now gives us more. The reader, when he comes to the bibliography at the end of this introductory section, is now no longer obliged to go to some library for further information. The "Encyclopædia" itself supplies it; for the introductory section is amplified by a series of articles by specialists on the pottery of ancient Egypt and Western Asia, Greek, Etruscan, and Roman wares, and further sections on Persian, Syrian, Egyptian, and Turkish pottery. This article on ceramics is certainly one of the fullest archæological articles in the work, but it is quite typical of the rest. We clearly have here a deliberate policy on the part of the editor and his assistants to furnish the reader not only with the dry bones of a skeleton, but with plenty of material to fill them out at will.

Another feature that has struck us during a careful study of the articles dealing with ancient history and archæology is the system of cross-references which has been adopted throughout. One obvious gain has naturally been to avoid repetition and inconsistency; but a further advantage consists in the fact that the reader is enabled to follow up various subsidiary lines of study in cognate articles treating the subject in greater detail or from a different aspect. We have already referred to the article on Ægean civilisation; the reader, if he so desires, may find further information in other important articles on Crete, Mycenæ, and the Troad; while the products of Ægean art are treated under the more technical articles. By such a system of cross-reference the value of the "Encyclopædia," not only as a work of reference, but also as a subject for detailed study, is vastly increased.

There is one point on which we have not touched, but which perhaps distinguishes more than any other this edition of the "Encyclopædia" from its predecessors—the number and beauty of the illustrations. Many of the old line blocks and wood engravings have naturally still great value, and where they have not been rendered obsolete or out of date, they have been retained; but they are supplemented by a wonderful series of half-tone plates, arranged clearly on both sides of the paper in order to save space, and containing, in some cases, as many as twelve or sixteen separate blocks to the page. For beauty of half-tone illustration it would be hard to beat the series of plates to the article on Greek art, while those to the article on gems, with their admirably clear classification, show what modern scientific illustration can achieve.

In the short account we have given of a single aspect of this great work, we have not attempted to criticise any article in detail, though in the course of our reading we have noted one or two slips. To select them for special mention from a work of such magnitude would be unfair, as it would tend to create a wrong impression. That so high a standard of accuracy should have been achieved is an eloquent testimony to the devotion of the editor, and of the distinguished band of specialists whom he numbers among his contributors.

L. W. K.

THE DATA OF PHYSICAL CHEMISTRY.

Physico-Chemical Tables, for the Use of Analysts, Physicists, Chemical Manufacturers, and Scientific Chemists. By John Castell-Evans. Vol ii., Physical and Analytical Chemistry. Pp. xiv+549–1235. (London: C. Griffin and Co., Ltd., 1911.) Price 36*s.* net.

THE second and concluding volume of Mr. Castell-Evans's work on physico-chemical constants is a veritable monument to the industry and perseverance of the author, who unhappily has not lived to reap the reward of his labours. The user of the tables may well be appalled at the magnitude of the task undertaken by a single compiler to bring out two volumes covering in detail the whole domain of physical chemistry and running in all to more than twelve hundred pages.

To review such a work adequately is almost impossible without keeping the book in hand for a longer time than is desirable. The reviewer's criticisms must therefore be taken as indicative of the directions in which a future edition might be improved, rather than as the results of a detailed examination; it should also be noted that in the circumstances the reviewer has refrained from raising debatable questions.

The distinguishing feature of the book is undoubtedly the very large amount of labour put into the calculation of the numerous tables, a great number of which are quite new and contain data only obtainable elsewhere from many scattered sources. For example, the collection of data on viscosities and on densities of liquids and their variation with temperature are most useful and complete. To the analytical chemist and assayer the two hundred pages of tables for shortening analytical computations, for the comparison of volume and weight percentages, and for the conversion of the various systems of units employed in such estimations, will be very valuable.

In the compilation of this second volume of tables even to a greater extent than in the first, the author seems to have allowed his extraordinary desire for high numerical accuracy to lead him to give the values of constant in many cases to far more figures than can possibly have any significance.[1]

As a sample physical measurement of the highest class under the best possible conditions may be considered the comparison of two similar platinum-iridium kilograms with all the refinements of a transposition balance, a "complete" set of weighings, and the utmost precautions. Under these conditions the thousandths of a milligram may be said to have some significance. Similarly in length measurements the difference in length between two similar standard metres of the highest class may be determined to a few hundredths of a micron, and the height of a metre column of mercury to a few thousandths of a millimetre. The last significant figure in the three cases is $1/10^9$, $1/10^8$, and $1/10^6$ of the whole respectively. These are the most favourable cases, but it seems unlikely that even with the best of methods an interval of temperature can be measured with greater precision than about one part in a hundred thousand. Besides, if instead of the mass or length chosen in the examples an odd multiple of a fundamental standard be taken, the precision attainable may be only one-tenth of that given or even less.

But Mr. Castell-Evans gives many instances of eleven and some even of fourteen significant figures among his constants and conversion factors, whereas for the purpose of avoiding mere errors of computation the retention of one, or at most two, additional places beyond the usual limits would have been amply sufficient.

While dealing with this question, it may be remarked that a physicist familiar with the modern precision measurements of physics, but whose mental estimate of the kind of accuracy now attainable in chemical work was obtained only from Mr. Castell-

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[1] The writer is informed that this retention of an unusually large number of figures was not due, as might have been supposed, to the use of a calculating machine whereby the extra digits were obtained without any very serious increase of labour, but that the numerical work was performed by the author without the aid of any machine.